The use of networking for K-12 education promises to be one of the basic tools for repairing what is, in many ways, a "broken" education system. As National Research Council ("NRC") has stated, the Internet "is a holy grail...[for] the K-12 education community, which should have greater access to it but has not been able to afford that access."[29] Through networking, schools will be able to gain access to a world of information resources that is not defined by the size of the local school budget, but rather is available across district lines, across income, even across national boundaries.

Currently, however, network access is stymied by costs and logistics. According to information submitted to the Department of Education, after insufficient funds and the associated lack of equipment, the most significant barrier to schools' acquisition of advanced telecommunications capabilities is "too few access points in building."[30] Even many schools with substantial computing resources still find it necessary to move classes to "the computer lab" where networking is possible, thus diluting many of the benefits that computers could provide to enrich the flow of classroom activities. As a result, computer competence and computer use often become ends in themselves, instead of aids to other instructional goals.

One of the core problems facing schools is, then, the "last link" problem — creating a connection from the point of entry of an infrastructure connection, to the computers themselves. Wireless technologies — particularly unlicensed wireless technologies, including the NII Band — are uniquely suited to solving this problem.

The Commission took the first major step in making this solution a reality when it created the Data-PCS band. As discussed above, Data-PCS devices will provide low cost, flexible means for last link connections supporting applications involving data rates of up to 10 Mbps. Increasingly, however, educators will require higher-bandwidth networking. As the NRC reported, "To achieve many

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29 "Realizing the Information Future: The Internet and Beyond." National Research Council, National Academy Press, Washington: 1994 at 11-12.

30 Department of Education, "Advanced Telecommunications in U.S. Public Schools, K-12," FCES 95-731, at 21 (Feb. 1995.).

of the benefits anticipated by educators will require access to the high-end networking that would make possible better video and multimedia exchanges. This implies higher bandwidth, reliable service, and so on. More sophisticated systems and higher bandwidth enable better graphical interfaces and functionalities."[31]

The NRC report continues by urging, among other things, access to current information sources, collaborations among students and teachers, a more active (as opposed to passive) acquisition of information and learning, reinforcement of basic learning skills, expansion of interests in sciences, and the "ability to build a bridge from school to home...". These networking features and their combined richness of information content will be best implemented in the NII Band, where signals can readily pass from one part of a school to another,[32] where bandwidth-intensive uses can be accommodated, and where, in many locales, the longer distances possible with directional antennas will help knit the home-school fabric.

2. Libraries.

Libraries long have served as a vital and opportunity-laden public resource. Over the years, they have evolved from repositories of books, to sources of diverse media including CD ROM data bases, video tapes, audio books, and music and drama recordings. In addition, increasingly they have become interconnected with other information resources, although, in the past, this has principally involved a physical connection, such as a dedicated telephone line.

As the form in which information is retained and distributed changes, however, libraries themselves know they must change if they are to continue to serve their core functions. New ways of exchanging information can make the long waits associated with inter-library loans of printed matter a thing of the past. Communications resources can provide access to on-line card catalogues,

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31 Id. at 126.

32 The mm waves will not pass so readily through walls as will the 5 GHz NII Band signals.

centralized scholarly databases, and a host of other resources to local users. In addition, they can make it possible for libraries to share their resources with individuals in other communities. Just as schools can provide students with access to the world's information resources, libraries can act as a gateway between entire communities and these resources, ensuring that every individual has a way to connect into and benefit from the information economy.

Currently, however, libraries are ill-equipped to serve this important role. There are about 15,000 public libraries (in addition to numerous corporate and private libraries) in the United States. But as of the middle of 1994, libraries with Internet access were numbered only in the hundreds, or fewer than 10%.[33] In light of funding constraints, it is unlikely that libraries will be able to expand significantly their offerings in the areas of computing and communications unless low cost, easily implemented alternatives are available to them.

The High-Performance Computing Act of 1991 recognized the importance of ensuring that libraries are connected to the nation's information infrastructure. Similarly, it is possible that Congress will pass legislation guaranteeing libraries at least limited access to the Information Superhighway. Yet while Congress can take some steps to promote access by public institutions such as libraries, as discussed above, private solutions, rather than government mandates, will need to be relied upon to a very significant extent in achieving this objective.

The NII Band can be an integral part of such a solution. Libraries are already starting to experiment with community and inter-library wireless networks as a means of achieving increased interconnectivity. Yet because there are as yet no adequate spectrum resources for unlicensed, wideband, wireless communications, there is no clear path for widespread deployment of such networks. The NII Band could provide this path and permit the deployment of unlicensed networks connecting libraries within a city, across a university campus, or especially, in rural America. As a noted expert stated:

> "[M]any communities, rural and urban, want network access, especially for their children now. While many have never heard of the "Super Highway,"...many others hope this will be the "yellow brick

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33 "Realizing the Information Future," *supra* n.29, at 139.

> road" out of isolation: lack of education, remoteness, being out of contact; out of vulnerability: increasing capacity to handle shocks and contingencies through contact with distant places and reciprocal relationships; out of powerlessness: ability to access resources, obtain legal redress and negotiate new possibilities."[34]

The NII Band could be used not only to connect buildings within or across library systems, but also to connect users within the library to information resources — whether the library's own or, via the Internet or another network, those housed elsewhere. For example, researchers and others could use computers with NII Band communications capabilities (through a wireless access point) to search the library system's electronic card catalog and collection of electronically-stored books, maps, and other reference sources, organize the results, compare those results with the results of other researchers at other institutions, and compile a consolidated, nationwide reference resource on a particular topic. Similarly, those who do not themselves have a computer and an Internet connection could use library computers and wireless connections to access government documents or communicate with colleagues or friends from the carrel or desk at which they are working.

Like the role played by the Carnegie Foundation more than a half-century ago, the federal government must "invest" in libraries by dedicating unlicensed wireless spectrum. This one-time in-kind investment will create a public resource that will inure to the benefit of generations to come, and play a critical role in preventing the creation of a society of information "haves" and "have nots."

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[34] Dr. Janet K. Poley, President of A*DEC, a consortium of land grant colleges and universities developing learning opportunities using technology, University of Nebraska-Lincoln, in "Ties That Bind: Rural Issues of Converging Communities." Proceedings of the [Ties That Bind] Conference sponsored by Apple Computer and the Morino Institute, May 2-5, 1995.

V. USE OF THE NII BAND MUST BE GOVERNED BY APPROPRIATE TECHNICAL RULES.

The success of the NII Band depends upon the adoption of a set of operating requirements to govern unlicensed use of the frequencies.[35] These requirements should be minimal and should establish standards at the lowest possible level in order to allow a wide variety of wireless communication options (much as the present Section 15.247 of the Commission's rules defines modulation techniques and power limits, but little else). The operating requirements also must be explicit enough at higher levels as to be consistent with the way digital information is communicated effectively.

While the development of a specific set of operating requirements for the NII Band will require a great deal of work and the input of a large number of interested parties, the following describes the essential attributes that would be mandated, as well as some general recommendations on the manner in which the requirements should be developed.

A. The NII Band Must Promote and Protect Equitable Access.

The rules governing the NII Band must assure that all devices retain an equitable right to access and share the spectrum resource. In particular, they must prohibit any rules for operation which are based upon (or display the preclusive behavior of) a circuit-switched network,[36] as well as any requirement (or exceptional priority) for centralized "gatekeepers."

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35 It has become common to refer to any set of channel access rules as an "etiquette." The term originally was applied to rules or procedures whereby dissimilar communications devices could defer to one another without any exchange of information, with a goal of minimizing interference. The term does not itself imply interoperation or signal-handling compatibility, and it would be premature to describe the NII Band rules as an "etiquette."

36 In packet-based transmissions, information is divided into discreet small pieces, or "packets," each of which is sent whenever a "channel" is free, using whatever route is available at that time. Thus, transmitting devices occupy a "channel" only for the very brief time it takes to send an individual packet. In contrast, on conventional telephony and other circuit-switched networks, once a circuit is established a user can stay connected indefinitely — in essence, circuits become the "property" of the first user in line, for as long as they want them. This can deprive other, later-starting circuit-dependent operations of access and can preclude any access at all for, or interrupt the transmission of, packets of data. The result is an inevitable inequity whenever the two

An essential quality of the NII Band is that, like the Internet and virtually all other data networks, it must be used only for packet-switched (or "connectionless") information transport. Moreover, each packet's "right" to access the spectrum must be equitable at all times. Any operating rules that incorporate a hierarchy among packets that permits certain types of packets to monopolize a transmission path by excluding other packets would, in essence, transform packet-based connections into traditional connection-based communications.

Similarly, any requirement (or "super-priority") for networks employing a centralized control mechanism that can deny other users access to the spectrum resource contradicts the essential nature of unlicensed operation. Some unlicensed networks (such as some wireless LANs), of course, will employ a central control function. Other users must be free, however, to communicate without obtaining the approval of, or deferring to, any type of hegemonic controller.

In designing its proposal for the NII Band, Apple has sought to identify a suitable amount of spectrum that will minimize the possibility of spectrum overcrowding. Even with a suitable allocation, however, there may be circumstances in which overcrowding occurs. In such cases, it is imperative that all communications share this burden equally (through delays in transmission times), rather than permitting some types of applications to monopolize the network at others' expense.

The fact that a particular type of traffic (*e.g.*, some voice circuits) may require a guaranteed service quality does not mean that this traffic is more "worthy" than other types of traffic. There is, quite simply, no correlation between the mode of transmission and the value of the content of the "message." For example, information critical to patient care could be contained in a voice

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(footnote continued)
functions are forced to share spectrum: connection-based circuits guaranteeing a high quality of service will consume the bandwidth they need, and packet data must accept whatever bandwidth, if any, is left over.

The WINForum organization spent many person-years attempting to create an "etiquette" pursuant to which isochronous (voice-like) and asynchronous (packet data-like) transmissions could share the unlicensed PCS band. Ultimately, WINForum proposed, and the Commission adopted, completely separate frequency bands, with totally different channel access and usage rules, for the two functions.

conversation between physicians (a voice circuit), in medical records (a data circuit), or in x-ray images (either a data or video circuit). Any effort to create a hierarchy among users based upon the transmission type is fundamentally misguided and should be rejected.

By providing for equal access, the Commission would not in any way preclude applications that deliver what appears (to the user) to be real-time voice, video or similarly time-dependent material. Creative developers and users have found ways to use the Internet (a packet-based network), for example, to convey and deliver live music performances and high-quality video without monopolizing the available communications bandwidth. There are continuing developments of Internet protocols, including those intended to convey ATM cells. Even though a "wireless ATM" has not been fully researched, it remains a possibility that should not be precluded; the capacity of the NII Band allocation may be the agent for full development of wireless ATM and other innovations.

There may, of course, be some types of communications for which the risk of delay inherent in true "packet-based" unlicensed operation will be unacceptable. These requirements, however, can be met using wired networks or a licensed, homogeneous wireless service (where quality of service can be guaranteed). Indeed, because overcrowding will most often occur in precisely the same densely-populated environments in which advanced wired networks will be deployed promptly, wired service will generally be an option reasonably available to these users.

The point is that the value of the NII Band could be undermined, unless steps are taken to prevent its saturation by telephony, entertainment-video, or other connection-based services, before technologies are invented to better accommodate mixtures of packet- and circuit-switched. The NII Band is not intended to be a substitute for other wireless and wired offerings. Rather, it is intended to be a complement to those offerings and its integrity should not be compromised to achieve objectives that are not needed in light of the capabilities of other types of networks.

B. Operating Conventions And Rules For The NII Band Should Be Developed By The Information Industry.

For the reasons discussed in the preceding section, it is imperative that the Commission play an active role in developing a set of broad objectives designed to assure that the NII Band actually will be used for the purposes that justify its creation. These objectives should be flexible enough to encourage innovation and technological evolution, but not so broad as to allow a variegated mix of incompatible users with mutually exclusive technical, operating, and quality of service characteristics and requirements. This only would duplicate on a larger scale the problems presently associated with traditional Part 15 unlicensed operation.

The FCC need not, however, take the lead in defining on a "micro" level the technical rules governing the NII Band. Instead, it should rely substantially on the expertise of a working group composed of industry experts, such as the Internet Architecture Board ("IAB") and its Internet Engineering Task Force ("IETF"), along with wireless data industry members.

A possible starting point for NII Band rules could be that any transport and service functionality that is consistent with, and successfully conveyed by, today's Internet, should be provided for in the NII Band rules. The converse should also prevail. As the Internet and other elements of the NII develop, the NII Band rules could be evolved as well to keep pace.

VI. THE COMMISSION SHOULD ALLOCATE THE 5150-5300 AND 5725-5875 MHZ BANDS TO CREATE THE NII BAND.

A. The 5150-5300 and 5725-5875 MHz Bands Are Uniquely Suited to Serve as an NII Band.

As discussed above, it is particularly appropriate to allocate the 5150-5300 MHz band to the NII Band, since this band already has been allocated in most of Europe for HIPERLAN. U.S. users and manufacturers, therefore, will benefit from the opportunities for interoperability, roaming, and increased exports that will flow from an NII Band allocation. Moreover, such an allocation will respond

to the desires of our trading partners for a HIPERLAN-type allocation within the United States, which likely will be expressed in international fora including, at WRC-95.[37]

The 5725-5875 MHz also is singularly appropriate as a component of the NII Band. It represents a large contiguous allocation that is not currently heavily used. Moreover, its allocation as part of the NII Band will mesh with — rather than displace — most or all existing and planned uses. Thus, by upgrading this band from traditional Part 15 to protected "Part 16" use, the Commission essentially will be able to create a 150 MHz resource capable of supporting the broad range of high-bandwidth services described above.[38]

Finally, these two NII Band segments make an attractive frequency-duplex pair. While computer networks do not often have the luxury of separate fore and back wiring, future developments (including the use of control channels) could open new opportunities for approaching even more closely the "guaranteed" quality of service of circuit-switched networks without sacrificing the equality that is so essential to the NII Band's success.

B. The Proposed Allocation Is Consistent With the Requirements of Other Spectrum Users.

1. The 5150-5300 MHz Band.

The 5150-5300 MHz Band is a shared government/non-government band that is not currently heavily used. The frequency range 5000-5250 MHz is allocated to the aeronautical radionavigation service and to the aeronautical mobile-satellite service on a primary basis.[39] In addition, it is allocated to the fixed-satellite service for earth station uplinks when these services are used in conjunction with the aeronautical radionavigation and/or aeronautical mobile

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[37] Questions concerning the HIPERLAN band are likely to arise at WRC-95 in light of the proposed use of an overlapping band for MSS feeder links.

[38] As noted previously, the "5800 MHz " band has slightly different frequency boundaries for operation under Sections 15.247 and 15.249. The allocation for Section 15.247 should be expanded to match that of Section 15.249, as well as the NII Band allocation.

[39] 47 C.F.R. § 2.106 and n. 733.

service.[40] Finally, a portion of this band (5150-5216 MHz) is also allocated for downlink feeder link transmissions used in conjunction with certain radiodetermination-satellite systems.[41]

The frequency range 5250-5350 is allocated to the radiolocation service on a primary basis for government operations and on a secondary basis for non-government operations; radiolocation stations installed on spacecraft may also be employed for the earth exploration-satellite and space research services on a secondary basis.[42] The band below 5000 MHz is allocated to the radio astronomy service on a primary basis and to space research (passive) operations on a secondary basis.[43]

The 5000-5250 MHz band was intended to be used principally for the operation of an international Microwave Landing Systems ("MLS") and, under the international allocation, the requirements of this system take precedence over other uses of the band.[44] In 1994, however, the United States canceled further development of its MLS system, preferring to concentrate instead on the use of the Global Positioning Satellite ("GPS") system for the next-generation aeronautical navigation system.[45] This decision likely will free up the 5150-5250 MHz band. Even if the United States ultimately decides to use MLS, sharing issues likely can be resolved because European nations also propose to employ MLS and, as a result, MLS-HIPERLAN compatibility will need to be addressed.

In addition, one licensee of a "Big LEO" mobile satellite system, Loral/Qualcomm Partnership, L.P. ("LQP"), has proposed to operate its system feeder (or gateway) uplinks in the 5025-5225 MHz band,[46] and two other MSS applicants have also urged the FCC to make this band available for MSS feeder

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40 Id. n.797.
41 Id nn.797A and US307.
42 Id. and n.713; for certain additional restrictions on operation within this band, see nn.US110 and G59.
43 47 C.F.R. § 2.106.
44 Id. n.796.
45 See, e.g., "FAA Cancels MLS in Favor of GPS," Aviation Week and Space Technology, Vol. 140, No. 24, at 33.
46 Application of Loral/Qualcomm Partnership, L.P., Order and Authorization, DA 95-128, ¶ 15 (released Jan. 31, 1995).

links.[47] This use of the band, however, would require a modification to the existing allocation at the upcoming WRC-95. If such use is authorized at WRC-95 and adopted by the Commission, the proposed NII Band could accommodate a limited number of U.S. MSS feeder link stations, such as has been proposed by LQP.

While the NII Band will not replicate exactly the HIPERLAN standard, as discussed above, the two bands will share many elements and will likely have similar sharing characteristics *vis-a-vis* other services, including MSS feeder links. The question of sharing between HIPERLAN and MSS feeder links was considered at the Conference Preparatory Meeting for WRC-95 and WRC-97, which concluded that HIPERLAN could share spectrum with MSS feeder uplinks, although a "quiet zone" around gateway uplink sites likely would be required[48] — not unlike the approach that will be used to protect radioastronomy locations from unwanted interference from unlicensed Data-PCS devices.

In light of the work that has already been done in this area, and because MSS systems will operate on a global basis and, therefore, sharing between HIPERLAN systems and MSS feeder uplinks will have to be resolved in a mutually acceptable manner, Apple is confident that an acceptable sharing scenario can be developed within the United States. To promote the development of such a sharing approach, Apple urges the Commission to take into consideration an NII Band allocation in developing and promoting the needs of MSS systems at WRC-95 and support efforts to maximize opportunities for operation of both MSS feeder links and NII Band devices within this band.

With respect to radiolocation services being provided in the 5250-5300 MHz band, there is insufficient information publicly available for Apple to

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47 E.g., Memorandum Opinion and Order, ET Docket No. 92-28, FCC 95-70, ¶ 14 (Mar. 20, 1995).

48 Conference Preparatory Meeting for WRC-95 and WRC-97, Document CPM95/118-E, at (Apr. 4, 1995) ("[i]t has been concluded that sharing between non-GSO/MSS feeder links and HIPERLANs is feasible in the uplink direction provided feeder link earth stations are separated on the order of 3 to 10 km from indoor HIPERLANs and 16 to 50 km for outdoor HIPERLANs.... This distance can be further reduced by taking into account local shielding.").

determine the extent to which this band is being used and the exact nature of operations in the band. However, Apple believes that the technical rules governing the NII Band can be designed in a manner that will promote sharing opportunities and is hopeful that NII Band technologies could share spectrum with existing and planned users of this band. Moreover, radiolocation services occupy only 50 MHz of the 300 MHz NII Band, which may create further opportunities for successful sharing.

2. The 5725-5875 MHz Band.

The 5725-5875 MHz band is allocated for use by U.S. military radiolocation services on a primary basis and for use by non-government Amateur operations on a secondary basis.[49] In addition, the band is used for ISM equipment and by Part 15 equipment.[50] The 5850-5875 MHz portion of the band is also allocated to fixed-satellite uplinks on a primary basis, although this use is limited to international inter-continental systems and is subject to case-by case electromagnetic compatibility analysis.[51] The 5830-5850 MHz portion of the band is also allocated for amateur-satellite service downlinks on a secondary basis.[52]

Operations throughout the 5725-5875 MHz band are constrained by the presence of ISM devices and the requirement that radiocommunications services using this band must accept any harmful interference caused by these devices.[53] Because NII Band technologies generally will be a more hospitable "neighbor" than ISM devices (which currently are not subject to power limitations or emission restrictions), the NII Band allocation likely will not adversely affect existing radiolocation or Amateur operations.

The technical rules governing the NII Band will be sufficiently broad to accommodate most, if not all, Part 15 devices deployed in, or currently planned for, this band. The NII Band operating rules will be even more flexible than the

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49 47 C.F.R. § 2.106 and n.G2.
50 47 C.F.R. § 2.106.
51 Id. and n.US245.
52 47 C.F.R. § 2.106 and n.808.
53 Id. n.806.

Data-PCS etiquette and, therefore, will not require segregation from most or all devices designed in accordance with Sections 15.247 or 15.249 of the Commission's rules. Moreover, Apple anticipates that Part 15 manufacturers will welcome the significant opportunities presented by the NII Band, even if, in a limited number of cases, slight adjustments in products are required. Finally, Part 15 manufacturers will have the opportunity to participate in the development of the NII Band technical rules and, therefore, will have an opportunity to assure that these rules appropriately accommodate existing and planned products.

With respect to ISM use of the band, the NII Band allocation could share spectrum with currently-deployed ISM devices. The question recently has been raised, however, about whether future ISM devices should comply with more restricted emission masks or other protections to assure that their use does not make it impossible or impracticable for the spectrum also to be used for communications purposes.[54] This question merits further consideration, in the context of the NII Band as well as other bands shared by Part 15 and ISM devices.

VII. CONCLUSION.

For the reasons stated herein, Apple requests that the Commission promptly issue a Notice of Proposed Rulemaking proposing the creation of an NII Band and the adoption of technical rules as outlined by Apple. The Commission should proceed expeditiously in order to assure that any decision at WRC-95 regarding MSS feeder links in the 5 GHz band appropriately protects future NII Band operation.

Expeditious action also is required to maximize the opportunities for developing the technical rules and business plans for the 5 GHz and above 40 GHz unlicensed bands harmoniously and in a manner that capitalizes upon each band's unique capabilities. Finally, due to the time it necessarily takes to design, develop, test, and deploy new communications products, it is imperative that the Commission move forward quickly if NII Band products are to take their

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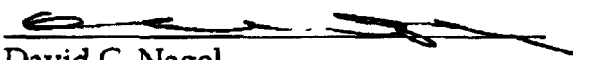
[54] Letter to Mr. Richard Smith, Chief, Office of Engineering and Technology, FCC, from Richard D. Parlow, Associate Administrator, NTIA (dated Apr. 12, 1995).

appropriate place within the overall NII and provide benefits to U.S. consumers, manufacturers, educators, and others in a timely manner.

Respectfully submitted,

APPLE COMPUTER, INC.



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May 24, 1995

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing Petition for Rulemaking was sent by first-class mail, postage prepaid, this 24th day of May, 1995, to each of the following:

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